

June 1996



Physics 30
Grade 12 Diploma Examination

Alberta
EDUCATION

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June 1996

Physics 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

Total possible marks: 70

This is a **closed-book** examination consisting of

- 37 multiple-choice and 12 numerical-response questions, of equal value, worth 70% (49 marks) of the examination
- 2 written-response questions, worth a total 30% (21 marks) of the examination

This examination contains sets of related questions. A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

A tear-out data sheet is included near the back of this booklet.

The blank perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A.** biology
B. physics
C. chemistry
D. science

Answer Sheet

Ⓐ ● Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

If a 121 N force is applied to a 77.7 kg mass at rest on a frictionless surface, the acceleration of the mass will be _____ m/s².

(Round and record your answer to three digits on the answer sheet.)

$$a = \frac{F}{m}$$

$$a = \frac{121 \text{ N}}{77.7 \text{ kg}} = 1.5572716$$

**Record 1.56 on the
answer sheet —**

1	.	5	6
	●	●	
○	○	○	○
●	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	●	5
6	6	6	●
7	7	7	7
8	8	8	8
9	9	9	9

Correct Order Question and Solution

Place the following types of EMR in order of increasing energy:

- 1 blue light
- 2 gamma radiation
- 3 radio waves
- 4 ultraviolet radiation

(Record your answer on the answer sheet

)

Answer: 3142

Record 3142 on the answer sheet →

3	1	4	2
---	---	---	---

•	•
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Scientific Notation Question and Solution

A hydrogen-like atom whose 3-2 transition emits light at 164 nm would have an E_1 value, expressed in scientific notation, of $-a.b \times 10^{-cd}$ J. The values of a , b , c , and d , respectively, are _____.

(Round and record your answer on the answer sheet)

Answer: 8718

Record 8718 on the answer sheet →

8	7	1	8
---	---	---	---

•	•
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Written Response

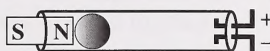
- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Descriptions and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.



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Use the following information to answer the next five questions.

Deployment of Air Bags

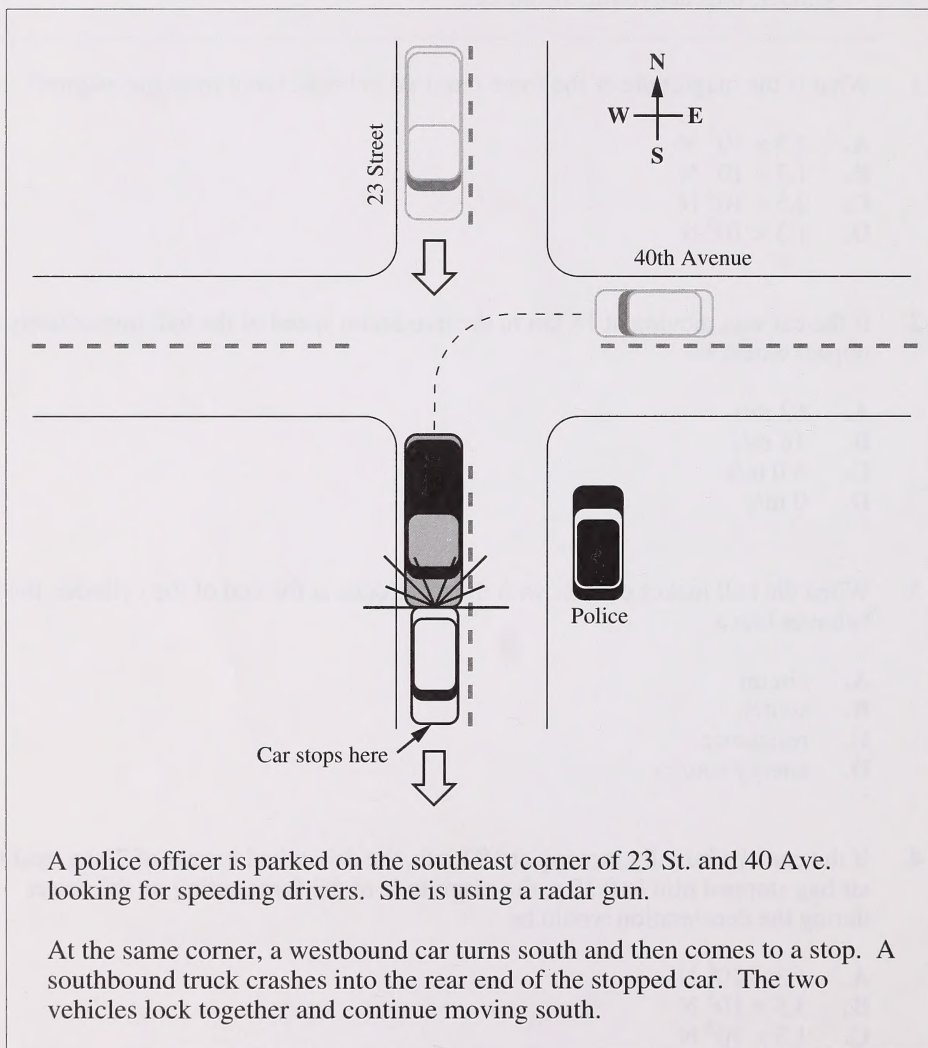


Air bags are designed to deploy when a car, moving at a minimum speed of 18 km/h, comes to a crashing stop. The impact sensor, also moving at 18 km/h, consists of a small steel ball of 0.050 kg, which is held in position by a magnet, as shown above. On impact, the ball breaks free in 1.00×10^{-3} s and slides within a cylinder. The ball makes contact with two electrodes at the end of the cylinder, thus activating the air bag.

1. What is the magnitude of the force required to break away from the magnet?
 - A. 2.5×10^5 N
 - B. 1.3×10^5 N
 - C. 2.5×10^2 N
 - D. 1.3×10^2 N
2. If the car was moving at 18 km/h, the maximum speed of the ball immediately after impact would be
 - A. 62 m/s
 - B. 18 m/s
 - C. 5.0 m/s
 - D. 0 m/s
3. When the ball makes contact with the electrodes at the end of the cylinder, the ball behaves like a
 - A. circuit
 - B. switch
 - C. resistance
 - D. energy source
4. If the car was initially moving at 18 km/h, the driver had a mass of 70 kg, and the air bag stopped him in 0.10 s, the magnitude of the force acting on the driver during the deceleration would be
 - A. 1.3×10^4 N
 - B. 3.5×10^3 N
 - C. 1.3×10^3 N
 - D. 3.5×10^2 N

5. The entire process, from impact to air bag inflation, takes less than 3.0×10^{-3} s. During this same time, how far forward would a passenger who was not wearing a seat belt move?
- A. 1.5×10^{-2} m
 - B. 1.8×10^{-2} m
 - C. 5.0 m
 - D. 0 m

Use the following information to answer the next six questions.



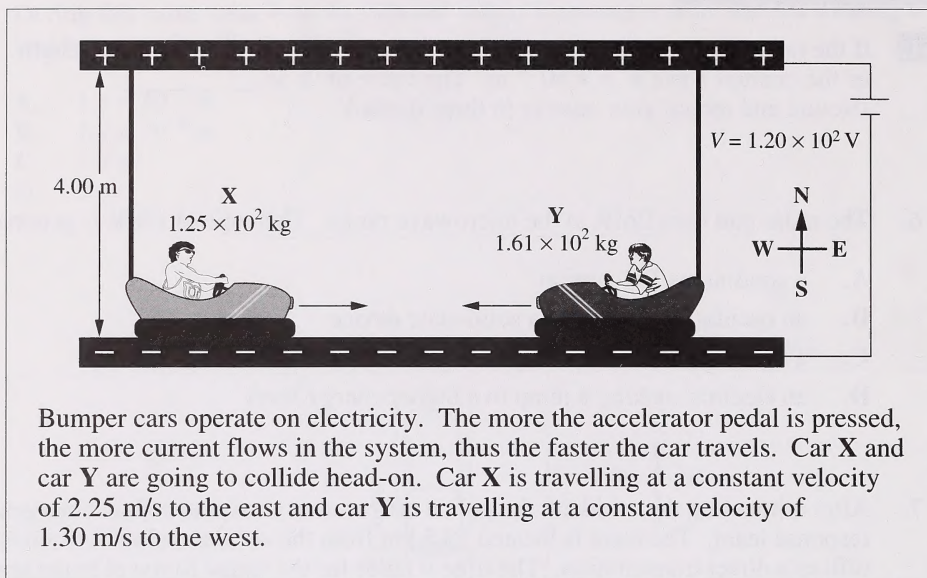
Numerical Response

1. If the radar gun uses EMR that has a period of 4.20×10^{-10} s, the wavelength of the emitted wave is $b \times 10^{-w}$ m. The value of b is _____.
(Round and record your answer to three digits.)
6. The radar gun uses EMR in the microwave range. This type of EMR is generated by
- A. a continuous DC current
 - B. an oscillating current in a solid-state device
 - C. a rapid deceleration of high energy electrons
 - D. an electron making a jump to a higher energy level
7. After witnessing the accident, the police officer uses a radio to call an emergency response team. The team is located 18.5 km from the accident when it receives the officer's direct transmission. The time it takes for the signal to travel to the team is
- A. 6.17×10^{-8} s
 - B. 1.62×10^{-7} s
 - C. 6.17×10^{-5} s
 - D. 1.62×10^{-4} s
8. The truck is equipped with a driver's-side air bag that was activated during the collision with the car. The main purpose of an air bag system is to
- A. shorten the stopping time of the driver's head and upper body as they move forward
 - B. act as a cushion and shield for glass and flying debris
 - C. lengthen the stopping time of the driver's head and upper body as they move forward
 - D. prevent the steering wheel from collapsing

Numerical Response

2. The car has a mass of 1850 kg. The truck was travelling at 65.1 km/h just before impact. After the car and truck locked together, they travelled at 26.2 km/h. The mass of the truck, expressed in scientific notation, is $b \times 10^w$ kg. The value of b is _____.
(Round and record your answer to three digits.)

Use the following information to answer the next three questions.



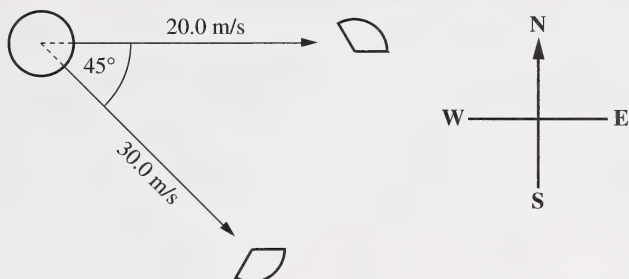
Bumper cars operate on electricity. The more the accelerator pedal is pressed, the more current flows in the system, thus the faster the car travels. Car X and car Y are going to collide head-on. Car X is travelling at a constant velocity of 2.25 m/s to the east and car Y is travelling at a constant velocity of 1.30 m/s to the west.

Numerical Response

3. The total mechanical energy of the bumper cars described, expressed in scientific notation, is $b \times 10^w \text{ J}$. The value of b is _____.
(Round and record your answer to three digits.)
9. If after the collision car Y is travelling at 0.526 m/s to the east, the velocity of car X immediately after impact would be
 - A. $1.02 \times 10^{-1} \text{ m/s}$ to the west
 - B. 3.25 m/s to the east
 - C. 4.60 m/s to the east
 - D. $1.02 \times 10^1 \text{ m/s}$ to the west
10. The electric field between the top and bottom grids of the system is
 - A. 30.0 N/C up
 - B. 30.0 N/C down
 - C. 480 N/C up
 - D. 480 N/C down

Use the following information to answer the next two questions.

A stationary bomb exploded in a street in the centre of a city. The three pieces of debris from the bomb, each of approximately the same mass, flew off horizontally in different directions. Analysis revealed that one piece moved east at 20.0 m/s, and a second piece moved southeast at 30.0 m/s.



11. The third piece of debris was difficult to locate. Where should investigators look for the third piece?
- A. 27° W of N
 - B. 27° N of W
 - C. 22.5° S of W
 - D. 22.5° N of E

Numerical Response

4. The speed of the third piece, expressed in scientific notation, is $b \times 10^w$ m/s. The value of b is _____.
(Round and record your answer to three digits.)

Use the following information to answer the next four questions.

A solar-powered battery maintainer is used to recharge batteries in automobiles. The maintainer uses a solar cell consisting of several cells in series. The solar cell has dimensions of $35.0\text{ cm} \times 12.0\text{ cm}$. It produces $1.00 \times 10^2\text{ mA}$ of current at 14.5 V under full-sun intensity.

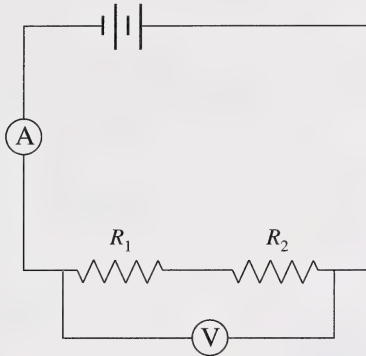
12. The number of electrons that pass one of the terminals during 1.00 s at 14.5 V under full-sun intensity is
- A. 1.60×10^{-20}
 - B. 1.60×10^{-17}
 - C. 6.25×10^{17}
 - D. 6.25×10^{20}
13. Increasing the area of the solar cell to 630 cm^2 would
- A. have no significant effect
 - B. decrease the current
 - C. increase the current
 - D. decrease the potential difference
14. To recharge a battery, electrons must be replaced. A typical automotive headlight operates with 1.0 A of current at 12 V . If the headlight is left burning for 1.0 h , what is the time required for the battery maintainer to replace the same number of electrons?
- A. $8.3 \times 10^{-1}\text{ h}$
 - B. $1.0 \times 10^1\text{ h}$
 - C. $1.0 \times 10^2\text{ h}$
 - D. $1.0 \times 10^3\text{ h}$

Numerical Response

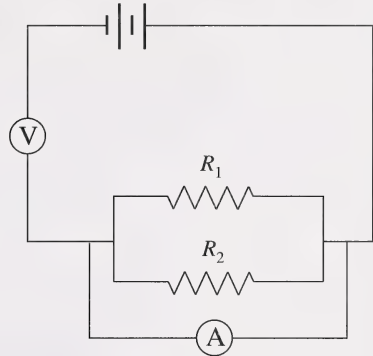
5. The average amount of energy being given to each electron by the solar cell, expressed in scientific notation, is $b \times 10^{-w}\text{ J}$. The value of b is _____. (Round and record your answer to three digits.)

15. A student wishes to verify that $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ for resistors in parallel. He has two known resistors, R_1 and R_2 , a power source, an ammeter, and a voltmeter. Which circuit should he set up?

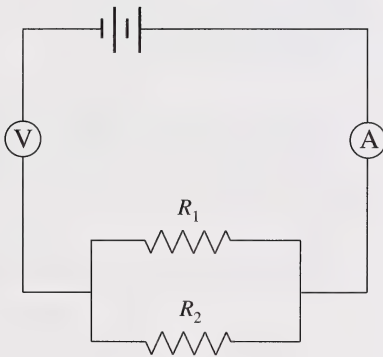
A.



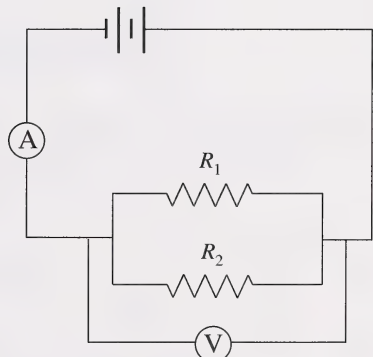
B.



C.

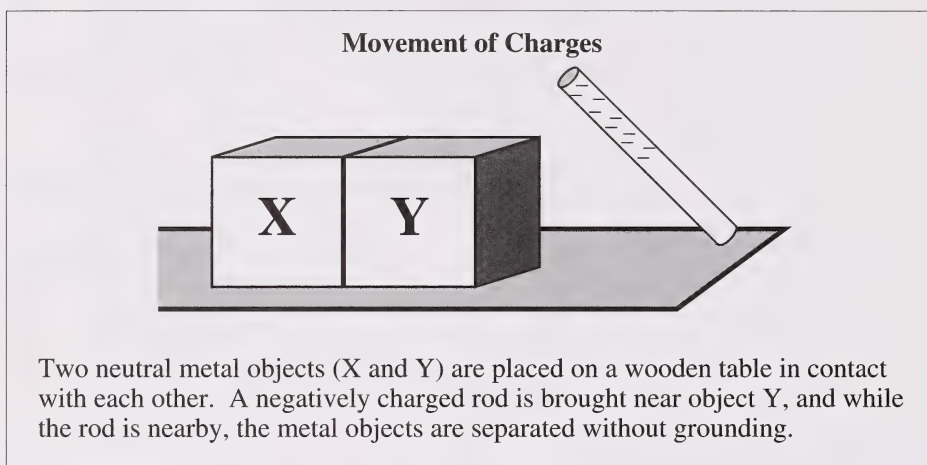


D.



16. Lightning maintains the potential difference between the surface of Earth and the ionosphere. In a typical lightning strike, 20 C of charge is transferred from the surface of Earth to a cloud through a potential difference of 3.0×10^7 V in 3.10×10^{-3} s. The electrical energy released in the lightning discharge is
- A. 6.1×10^{13} J
 - B. 1.9×10^{11} J
 - C. 6.0×10^8 J
 - D. 1.9×10^6 J

Use the following information to answer the next question.

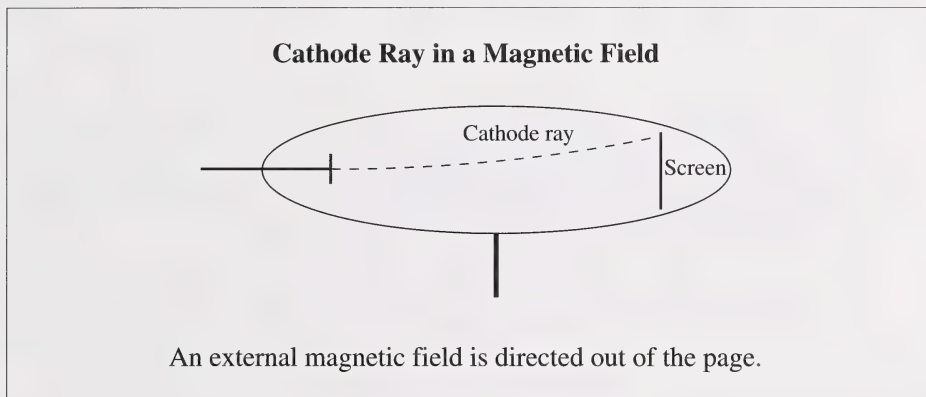


17. Which statement correctly describes what has occurred after the charged rod was removed?
- A. Object X received a negative charge by conduction, and object Y received a positive charge by conduction
 - B. Object X received a negative charge by induction, and object Y received a positive charge by induction
 - C. Objects X and Y both received a negative charge by induction
 - D. Objects X and Y both received a negative charge by conduction

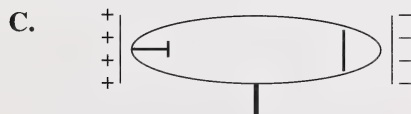
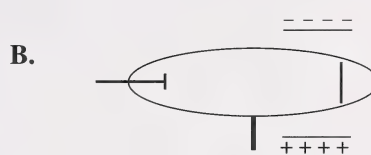
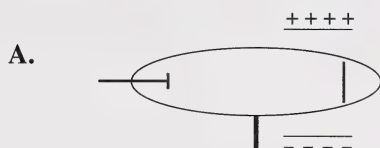
18. Which of the following quantities must be represented as scalar?

- A. Velocity
- B. Magnetic force
- C. Acceleration
- D. Electric potential

Use the following information to answer the next question.

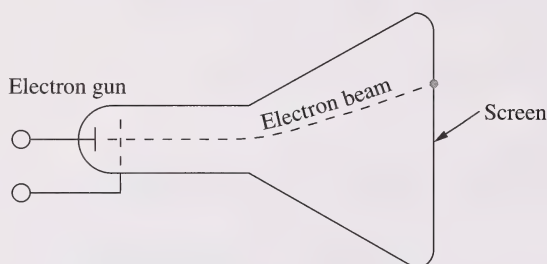


19. A magnetic field directed out of the page caused the cathode rays to move up the screen. What arrangement of electric plates would cause them to return to the centre?



Use the following information to answer the next three questions.

Television Picture Tube



The following is a simplification of what takes place in a television picture tube. The picture tube has an electron gun (left end) shooting a beam of electrons at a fluorescent screen. When an electron beam contacts the screen, the screen glows to produce one dot of the picture. The beam is directed at different parts of the screen to create the entire picture.

A colour television screen contains dots of three different phosphorescent materials that glow red, green, or blue.

Numerical Response

6. An electron from the beam hits an atom of the phosphor, causing it to make a transition to a higher energy level. A short time later, the atom makes a transition to the original state, releasing a photon of red light with wavelength 7.02×10^{-7} m. In order to provide sufficient energy, the electron must be moving at a speed of at least $b \times 10^w$ m/s. Expressed in scientific notation, the value of b is _____. (Round and record your answer to three digits.)

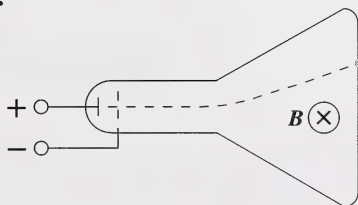
Numerical Response

Use your **recorded** answer from **Numerical Response 6** to answer **Numerical Response 7**.

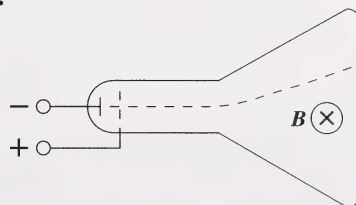
- 7.** The voltage that would be required to accelerate the electron to the speed recorded in Numerical Response 6, expressed in scientific notation, is $b \times 10^w$ V. The value of b is _____.
(Round and record your answer to three digits.)

- 20.** Assume that \odot represents B out of the page and \otimes represents B into the page. The electrical polarity of the electron gun and magnetic field orientation that will cause the electron beam to pass through the tube and deflect upward is shown in

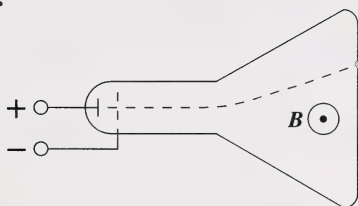
A.



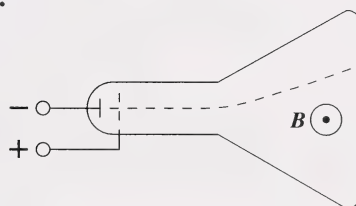
B.



C.



D.

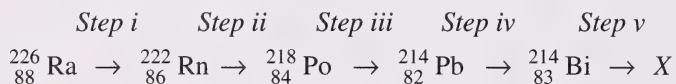


21. Three common types of radiation occur during natural decay: alpha, beta, and gamma. Descriptions of alpha, beta, and gamma radiation, respectively, are
- electromagnetic radiation, He^{2+} , electrons
 - electrons, electromagnetic radiation, He^{2+}
 - He^{2+} , electrons, electromagnetic radiation
 - He^{2+} , electromagnetic radiation, electrons
22. Some forms of radiation beams can be bent by passing them through an electric or magnetic field. This could be a useful process for focusing radioactive emissions. This method could be applied to
- alpha and beta radiation
 - alpha and gamma radiation
 - beta and gamma radiation
 - alpha, beta, and gamma radiation

Use the following information to answer the next three questions.

Around the start of the 20th century, Marie Curie and her husband Pierre used chemical techniques to isolate the radioactive element radium.

Steps in the decay sequence of Radium 226 were later established to be



23. If *Step v* in the given transmission of Radium 226 occurs as the result of beta emission, substance *X* is
- ${}_{82}^{213}\text{Pb}$
 - ${}_{84}^{214}\text{Po}$
 - ${}_{81}^{210}\text{Ti}$
 - ${}_{82}^{214}\text{Pb}$

24. The half-life of Radon 222 is 3.82 days. Given a 35.0 g sample, how many days will it take for the mass of the radon to be reduced to 2.19 g?
- A. 0.417 days
 - B. 8.37 days
 - C. 15.3 days
 - D. 16.0 days
25. Which other step is accomplished by beta emission?
- A. *Step i*
 - B. *Step ii*
 - C. *Step iii*
 - D. *Step iv*
-

Numerical Response

8. According to Einstein (1905), mass defect can be explained by assuming that an equivalent amount of energy is carried away by an energetic photon. The amount of energy equivalent to the mass defect could be predicted by the famous equation $E = mc^2$. Assuming that the mass defect is 9.00×10^{-30} kg, the frequency of the photon that corresponds to that energy, expressed in scientific notation, is $b \times 10^w$ Hz. The value of b is _____.
(Round and record your answer to three digits.)

Use the following information to answer the next two questions.

Food preservation is an ongoing human concern. A new technology, food irradiation, preserves food by destroying parasites and micro-organisms, and inhibiting sprouting. This is accomplished by passing the food through a thick-walled chamber containing a source of radiation such as Cobalt-60 that produces gamma rays. The half-life of Cobalt-60 is 5.3 years.

26. In 1994, a new Cobalt-60 unit could irradiate 10 000 kg of potatoes per day. By the year 2010, the rate of flow of potatoes through this unit should be reduced to about
- A. 5000 kg per day
 - B. 2500 kg per day
 - C. 1200 kg per day
 - D. 600 kg per day

Use the following additional information to answer the next question.

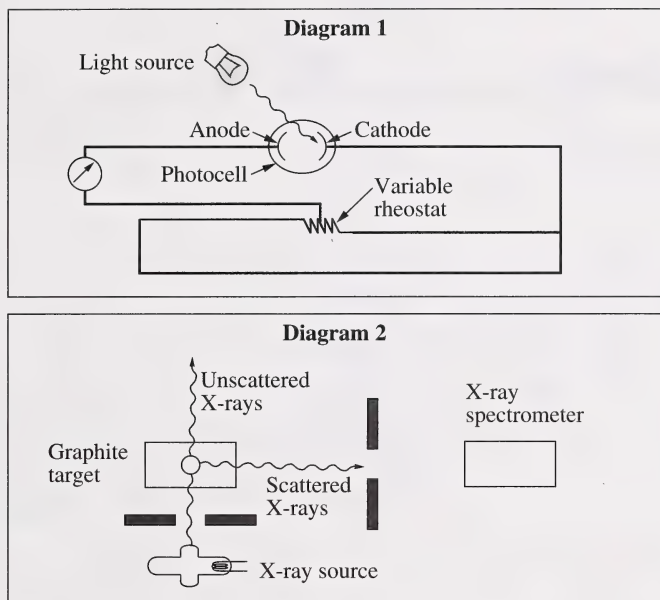
Excerpt from the Periodic Table

5	B 2.0	6	C 2.5	7	N 3.0	8	O 3.5	9	F 4.0	10	Ne —
Boron		Carbon		Nitrogen		Oxygen		Fluorine		Neon	
10.81		12.01		14.01		16.00		19.00		20.17	

27. If alpha radiation were used instead of gamma radiation, there might be a problem with transmutation of elements in the food. Which of the following transmutations produces alpha radiation?
- A. Oxygen to fluorine
 - B. Oxygen to neon
 - C. Carbon-12 to radioactive Carbon-14
 - D. Carbon to nitrogen
-
28. A fluorescent light tube contains a gas mixture at low pressure. When a current is passed through the tube, it gives off light energy because the
- A. electron orbitals of the gas atoms decay according to Maxwell's Laws
 - B. electrons of the gas atoms are initially excited to higher energy levels
 - C. electrical energy transforms to vibrational energy in the atomic band
 - D. electrical current is scattered by the nuclei of the gas atoms

Use the following information to answer the next four questions.

Following the introduction of quantum theory in the early 1900s, the centuries-old arguments concerning the wave or particle nature of light and other electromagnetic radiation were reinvestigated. The diagrams below depict experiments performed to demonstrate the particle properties of electromagnetic waves.



29. The two experiments depicted successfully proved that EM wave photons are similar to particles in that they both have
- A. wavelength and momentum
 - B. energy and momentum
 - C. energy and wavelength
 - D. energy and frequency
30. The experiments depicted in the diagrams were used to prove theories concerning particle properties of EM waves described by
- A. Einstein and Compton
 - B. Einstein and de Broglie
 - C. Einstein and Rutherford
 - D. Compton and de Broglie

31. Louis de Broglie proposed a hypothesis that was related to which of the following statements?
- A. The energy absorbed by an atom is the same as the energy released by the atom.
 - B. If light has particle properties, then particles may have wave properties.
 - C. The intensity of light controls the current in the photoelectric effect.
 - D. Energy and mass are related.

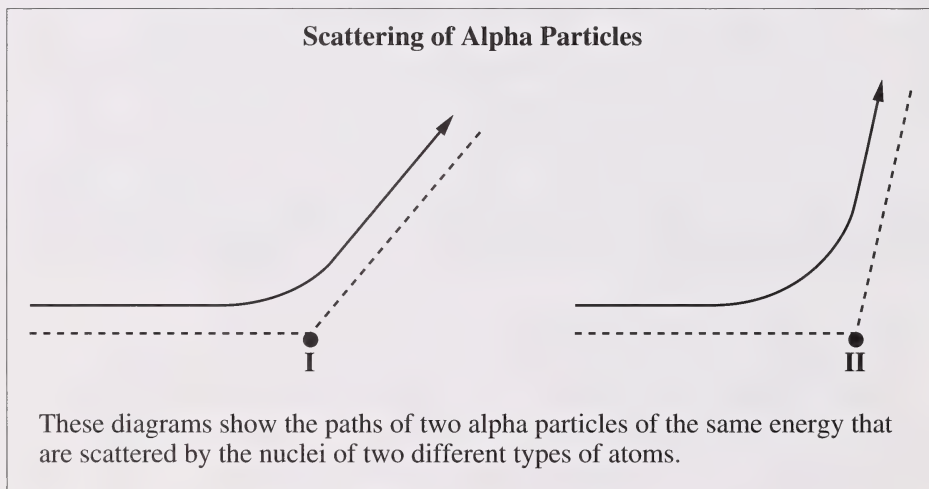
Numerical Response

9. If the photoelectron is emitted with a speed of 6.8×10^5 m/s, the kinetic energy of the electron, expressed in scientific notation, is $a.b \times 10^{-cd}$ J.

Answer: _____

(Round and record your answer as abcd)

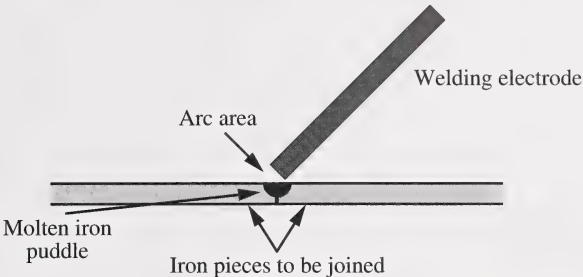
Use the following information to answer the next question.



32. Which statement correctly explains the difference in the deflection of the alpha particle?
- A. The size of nucleus II is greater than the size of nucleus I.
 - B. The mass of nucleus II is greater than the mass of nucleus I.
 - C. The charge on nucleus II is greater than the charge on nucleus I.
 - D. The charge on the particle scattered by nucleus II is greater than the charge on the particle scattered by nucleus I.

Use the following information to answer the next two questions.

Electrical Welding



The diagram illustrates the electrical welding process. A welding electrode, shown as a thick, dark, angled bar, is positioned above two horizontal iron pieces labeled 'Iron pieces to be joined'. An 'Arc area' is indicated by a small dark spot at the tip of the electrode where it meets the iron. Below this point, a 'Molten iron puddle' is shown as a dark, irregular shape. Arrows point from the labels to their respective parts in the diagram.

An electric-arc welder can join iron pieces by melting a section of each piece and allowing the molten iron puddles to run together. Upon cooling, one piece is formed. The heat required is produced by an electrical discharge (the arc) between the iron to be joined and the welding electrode. To join pieces of iron 0.30 cm thick, the welder, when set to an output of 32.0 V, will send 100 A of current between the electrode and the iron. A transformer is used to convert from 220 V to the required welding voltage.

Numerical Response

- 10.** The arc welder is operated from a 220 V outlet and used to join the pieces of iron. The amount of current that flows through the outlet is _____ A.
(Round and record your answer to three digits.)
- 33.** If the energy supplied to the arc welder is supplied from a wall outlet at home, the welder requires a second transformer to convert from 110 V to an operating voltage of 220 V. Several procedures are described below.
- I. Double the number of turns on the primary coil of the second transformer
 - II. Half the number of turns on the primary coil of the second transformer
 - III. Double the number of turns on the secondary coil of the second transformer
 - IV. Half the number of turns on the secondary coil of the second transformer

Which of these procedures would produce the desired result?

- A. I or III
- B. I or IV
- C. II or III
- D. II or IV

34. A group of hydrogen atoms are in the excited $n = 4$ state. As they drop to the ground state, the maximum number of **different** wavelengths of photons that could be emitted is
- A. 1
 - B. 2
 - C. 4
 - D. 6

Numerical Response

11. The energy of an electron in the third energy level of hydrogen is _____ eV.
(Round and record your answer to three digits.)

Use the following information to answer the next two questions.

An electron drops from the third energy level to the second energy level of an excited hydrogen atom.

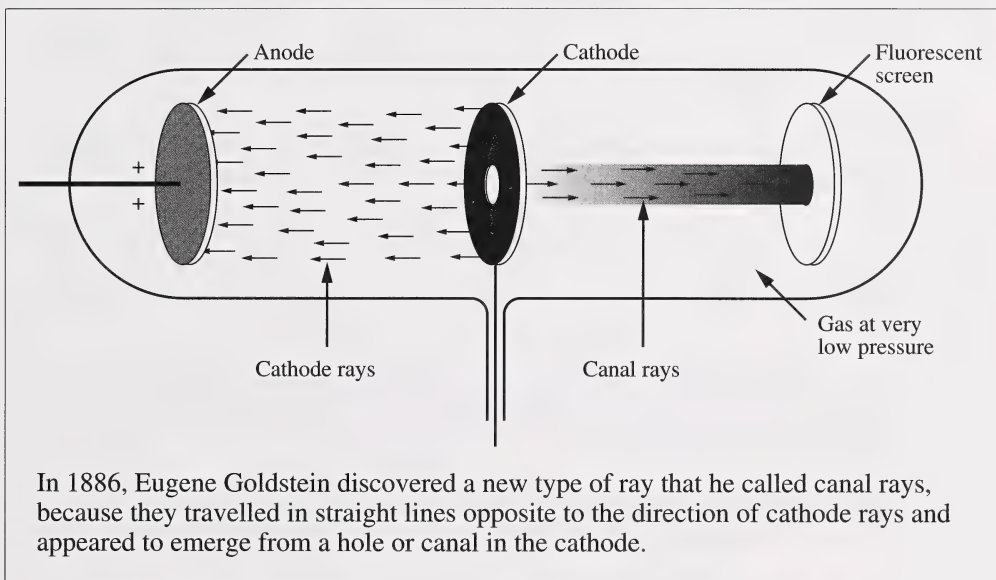
35. The wavelength of the photon emitted is
- A. 5.45×10^{-7} m
 - B. 6.55×10^{-7} m
 - C. 1.53×10^6 m
 - D. 1.83×10^6 m

Numerical Response

12. The energy of the emitted photon, expressed in scientific notation, is $b \times 10^{-w}$ J.
The value of b is _____.
(Round and record your answer to three digits.)

36. When a certain material is irradiated with ultraviolet light of wavelength $4.0 \times 10^{-8} \text{ m}$, it releases photoelectrons having a maximum kinetic energy of 30.0 eV. The work function of the material is
- A. $1.7 \times 10^{-19} \text{ J}$
 - B. $4.8 \times 10^{-18} \text{ J}$
 - C. $5.0 \times 10^{-18} \text{ J}$
 - D. $4.0 \times 10^{-9} \text{ J}$

Use the following information to answer the next question.



37. By placing either a magnetic or electric field between the cathode and the screen, the canal rays can be bent. This would indicate they are
- A. charged particles
 - B. mechanical waves
 - C. uncharged particles
 - D. electromagnetic waves

Written Response – 11 marks

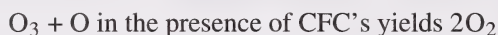
Use the following information to answer written-response question 1.

Applied Physics

Ozone, O_3 , is naturally produced and decomposed in Earth's upper atmosphere. It is well established that ozone acts as a filter for much of the ultraviolet radiation that impacts on Earth. The production and decomposition of ozone can be described by the reactions in the following cycle.

- I. $O_2 + \text{photon energy greater than } 8.25 \times 10^{-19} \text{ J yields } 2O$
- II. $O + O_2 \text{ in the presence of a catalyst yields } O_3$
- III. $O_3 + \text{photon energy in the range of } 6.22 \times 10^{-19} \text{ J to } 7.10 \times 10^{-19} \text{ J yields } O_2 + O$

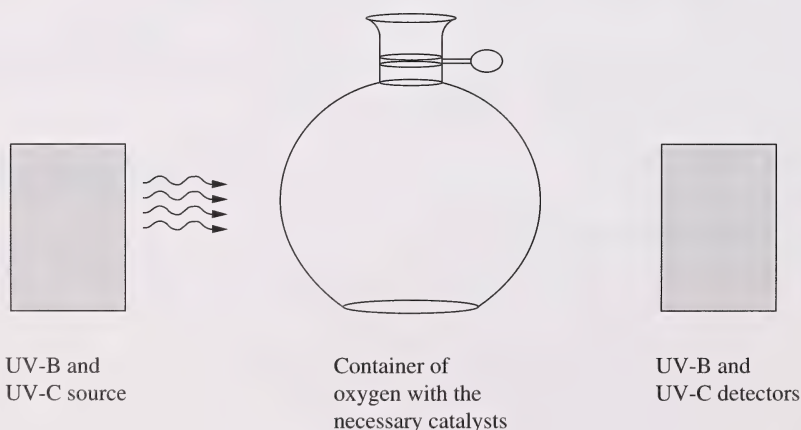
A different ozone decomposition reaction results from the presence of certain substances such as chlorofluorocarbons in the upper atmosphere.



A decrease in the ozone layer may cause an increase in the amount of skin cancer in humans.

To study the production of ozone and its ability to filter out (absorb) harmful UV radiation, students filled a glass container with pure oxygen (O_2) and passed UV radiation through the container.

The average wavelength for UV-B is 300 nm and for UV-C it is 240 nm. To verify reactions I, II, and III, the following simulation was designed.



1. After the ultraviolet source consisting of UV-B and UV-C is turned on, it is expected that ozone will be produced. Describe qualitatively how the concentrations of O_2 and O_3 in the glass container will change when the ultraviolet radiation passes through the container.

In your answer, state which radiation will cause reaction I and which will cause reaction III. Include any relevant calculations.

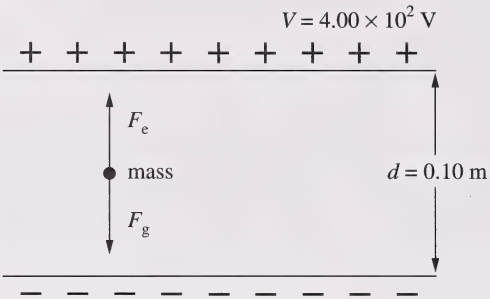
In addition, discuss qualitatively how the number of photons of UV-B and UV-C will change at the detectors.

Note: A maximum of 8 marks will be awarded for the physics used in your answer.
A maximum of 3 marks will be awarded for the effective communication of your response.

Written Response – 10 marks

Use the following information to answer written-response question 2.

A Millikan Experiment



A charged particle that has a mass of 2.8×10^{-16} kg accelerates upward at 3.6 m/s^2 in the electric field between two horizontal plates that have a separation of 0.10 m. The potential difference across the plates is 4.0×10^2 V. The experiment is performed on Earth's surface at sea level.

2. a. Calculate the magnitude and direction of the electric force exerted upon the particle.

- b. Determine the charge on the particle. (If you were unable to answer part a, use the hypothetical value $F_e = 2.6 \times 10^{-15}$ N.)
- c. Determine the time required for the particle to move from the lower to the upper plate when the particle begins at rest.

(parts d. and e. are on page 24)

- d.** Assume that the voltage applied to the plates can be varied. Calculate the minimum voltage needed to move the particle from the lower plate to the upper plate. (If you were unable to answer part **b**, use the hypothetical value $9.6 \times 10^{-19} \text{ C}$ as the charge on the particles.)
- e.** Assume now that the particle is initially at rest between the plates. If the charges on the plates were inverted (negative plate becomes positive, and positive plate becomes negative), what would be the magnitude and direction of the net force on the particle?



*You have now completed the test.
If you have time, you may wish to check your answers.*

PHYSICS DATA SHEETS

CONSTANTS

Gravity, Electricity, and Magnetism

Acceleration Due to Gravity or Gravitational Field Near Earth	a_g or $g = 9.81 \text{ m/s}^2$ or 9.81 N/kg
Gravitational Constant	$G = 6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$
Mass of Earth	$M_e = 5.98 \times 10^{24} \text{ kg}$
Radius of Earth.....	$R_e = 6.37 \times 10^6 \text{ m}$
Coulomb's Law Constant.....	$k = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
Electron Volt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
Elementary Charge	$e = 1.60 \times 10^{-19} \text{ C}$
Index of Refraction of Air	$n = 1.00$
Speed of Light in Vacuum	$c = 3.00 \times 10^8 \text{ m/s}$

Atomic Physics

Energy of an Electron in the 1st Bohr Orbit of Hydrogen	$E_1 = -2.18 \times 10^{-18} \text{ J}$ or -13.6 eV
Planck's Constant	$h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$
Radius of 1st Bohr Orbit of Hydrogen	$r_1 = 5.29 \times 10^{-11} \text{ m}$
Rydberg's Constant for Hydrogen	$R_H = 1.10 \times 10^7/\text{m}$

Particles

	Rest Mass	Charge
Alpha Particle.....	$m_\alpha = 6.65 \times 10^{-27} \text{ kg}$	α^{2+}
Electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$	e^-
Neutron.....	$m_n = 1.67 \times 10^{-27} \text{ kg}$	n^0
Proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$	p^+

Trigonometry and Vectors

$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

For any Vector \vec{R}

$$R = \sqrt{R_x^2 + R_y^2}$$

$$\tan \theta = \frac{R_y}{R_x}$$

$$R_x = R \cos \theta$$

$$R_y = R \sin \theta$$

Prefixes Used With SI Units

Prefix	Symbol	Exponential Value
pico	p	10^{-12}
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
centi	c	10^{-2}
deci	d	10^{-1}

Prefix	Symbol	Exponential Value
tera	T	10^{12}
giga	G	10^9
mega	M	10^6
kilo	k	10^3
hecto	h	10^2
deka	da	10^1

EQUATIONS

Kinematics

$$\bar{v}_{\text{ave}} = \frac{\bar{d}}{t}$$

$$\bar{a} = \frac{\bar{v}_f - \bar{v}_i}{t}$$

$$\bar{d} = \bar{v}_i t + \frac{1}{2} \bar{a} t^2$$

$$\bar{d} = \bar{v}_f t - \frac{1}{2} \bar{a} t^2$$

$$\bar{d} = \left(\frac{\bar{v}_f + \bar{v}_i}{2} \right) t$$

$$v_f^2 = v_i^2 + 2ad$$

Dynamics

$$\vec{F} = m\vec{a}$$

$$\vec{F}t = m\Delta\vec{v}$$

$$\vec{F}_g = m\vec{g}$$

$$F_f = \mu F_N$$

$$\vec{F}_s = -k\vec{x}$$

$$F_g = \frac{Gm_1m_2}{r^2}$$

$$g = \frac{Gm_1}{r^2}$$

$$F_c = \frac{mv^2}{r}$$

$$F_c = \frac{4\pi^2mr}{T^2}$$

Momentum and Energy

$$\vec{p} = m\vec{v}$$

$$W = Fd$$

$$W = \Delta E = Fd \cos \theta$$

$$P = \frac{W}{t} = \frac{\Delta E}{t}$$

$$E_k = \frac{1}{2}mv^2$$

$$E_p = mgh$$

$$E_p = \frac{1}{2}kx^2$$

Waves and Light

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T = \frac{1}{f}$$

$$v = f\lambda$$

$$\frac{\lambda_1}{2} = l; \quad \frac{\lambda_1}{4} = l$$

$$\frac{\sin \theta_1}{\sin \theta_2} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$$

$$\lambda = \frac{xd}{nl}$$

$$\lambda = \frac{d \sin \theta}{n}$$

$$m = \frac{h_i}{h_0} = \frac{-d_i}{d_0}$$

$$\frac{1}{f} = \frac{1}{d_0} + \frac{1}{d_i}$$

EQUATIONS

Electricity and Magnetism

$$F_e = \frac{kq_1q_2}{r^2}$$

$$|\vec{E}| = \frac{kq_1}{r^2}$$

$$\vec{E} = \frac{\vec{F}_e}{q}$$

$$|\vec{E}| = \frac{V}{d}$$

$$V = \frac{\Delta E}{q}$$

$$R = R_1 + R_2 + R_3$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$I_{\text{eff}} = 0.707 I_{\text{max}}$$

$$V = IR$$

$$P = IV$$

$$I = \frac{q}{t}$$

$$F_m = IlB_{\perp}$$

$$F_m = qvB_{\perp}$$

$$V = lvB_{\perp}$$

$$\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$$

$$V_{\text{eff}} = 0.707 V_{\text{max}}$$

Atomic Physics

$$hf = E_{k_{\text{max}}} + W$$

$$W = hf_0$$

$$E_{k_{\text{max}}} = qV_{\text{stop}}$$

$$E = hf = \frac{hc}{\lambda}$$

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$E_n = \frac{1}{n^2} E_1$$

$$r_n = n^2 r_1$$

$$N = N_0 \left(\frac{1}{2} \right)^n$$

Quantum Mechanics and Nuclear Physics

$$E = mc^2$$

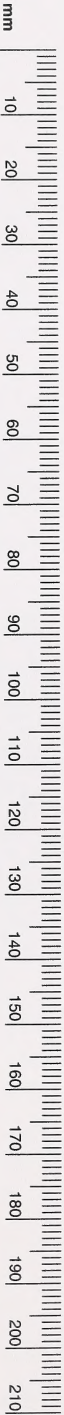
$$p = \frac{h}{\lambda}$$

$$p = \frac{hf}{c}; \quad E = pc$$

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No marks will be given for work done on this page.



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